

CLAIMS

[1] An inter-station transmission method used in a mobile communication system, the mobile communication system comprising a mobile station and a base station which is operable to return
5 to the mobile station by means of a TDMA system a response packet in response to a packet received from the mobile station, within a same time slot as that used for receiving the packet, wherein the base station includes:

at least one radio base station operable to demodulate
10 an uplink packet signal received from the mobile station and extract uplink transmission data, and to modulate downlink transmission data to be transmitted to the mobile station and generate a downlink packet signal;

a communication control station operable to receive
15 the uplink transmission data from the at least one radio base station, generate downlink transmission data corresponding to the uplink transmission data and transmit the downlink transmission data to the at least one radio base station; and

at least one inter-station transmission path which
20 establishes a wired connection between the at least one radio base station and the communication control station,

the uplink transmission data is transmitted, from the at least one radio base station to the communication control station, in a TDMA frame format which is used for a radio link between the
25 at least one radio base station and the mobile station, and

in the communication control station, the uplink transmission data received from the at least one radio base station is processed in the TDMA frame format.

[2] The inter-station transmission method according to claim

5 1, wherein

the downlink transmission data is transmitted, from the communication control station to the at least one radio base station, in the TDMA frame format, and

10 in the at least one radio base station, the downlink transmission data received from the communication control station is processed in the TDMA frame format.

[3] The inter-station transmission method according to claim 2, wherein

15 the downlink transmission data is transmitted, from the communication control station, in accordance with a predetermined communication control station transmission clock, and

in the at least one radio base station,
a radio base station reception clock synchronized with
20 the communication control station transmission clock is reproduced from the downlink transmission data received from the communication control station, and

the downlink transmission data is processed by using the radio base station reception clock.

25 [4] The inter-station transmission method according to claim

3, wherein the radio base station reception clock is reproduced in the at least one radio base station by using PLL control.

[5] The inter-station transmission method according to claim 3, wherein

5 in the communication control station, a communication control station reception clock, which results from multiplying or dividing the communication control station transmission clock by n (n is a natural number), is used to receive the uplink transmission data, and

10 in the at least one radio base station,

 a radio base station operation clock is generated by multiplying the radio base station reception clock by m (m is an integer greater than 1),

 the uplink transmission data is transmitted by using
15 a radio base station transmission clock which results from multiplying or dividing the radio base station operation clock by k (k is a natural number) and has a frequency synchronized with the communication control station reception clock, and

 a phase difference, which occurs according to the
20 length of the at least one inter-station transmission path, between the radio base station transmission clock and the communication control station reception clock is adjusted by a clock unit of the radio base station operation clock.

[6] The inter-station transmission method according to claim
25 1, wherein

when a response signal is transmitted from the communication control station, only a payload portion of the response packet is transmitted to the at least one radio base station, and

in the at least one radio base station, transmission of the
5 response packet is begun with a predetermined timing, by using header information previously retained, without waiting for an arrival of the payload portion from the communication control station.

[7] The inter-station transmission method according to claim
10 3, wherein

a plurality of the radio base stations are connected to the communication control station respectively via the plurality of inter-station transmission paths, and

each of the plurality of radio base stations adjusts, by
15 a clock unit of the radio base station operation clock, a delay time difference, which occurs according to the length of the inter-station transmission path, between a downlink transmission path delay and a predetermined transmission path delay.

[8] The inter-station transmission method according to claim
20 1, wherein

the plurality of radio base stations are connected to the communication control station respectively via the plurality of inter-station transmission paths, and

in the communication control station,
25 a plurality of pieces of uplink transmission data,

which are respectively outputted from the plurality of radio base stations and correspond to a same packet received from the mobile station, are received in a predetermined slot,

a reception timing of uplink transmission data is
5 detected, the uplink transmission data corresponding to the packet having been first received, and

a selection process is performed only on uplink transmission data which has been received before a predetermined period of time has passed after the reception timing.

10 [9] The inter-station transmission method according to claim 8, wherein the predetermined period of time is set according to a length of an area covered by the plurality of radio base stations.

[10] The inter-station transmission method according to claim 8, wherein the predetermined period of time is set according to
15 a length of a longest inter-station transmission path among the plurality of inter-station transmission paths.

[11] The inter-station transmission method according to claim 3, wherein in the communication control station, the downlink transmission data, into which dummy data for reproducing the radio
20 base station reception clock is inserted, is transmitted in a period which is within the TDMA frame and in which a channel data packet to be transmitted is not present.

[12] A radio base station monitoring method used in a mobile communication system, the mobile communication system comprising
25 a mobile station and a base station which is operable to return

to the mobile station by means of a TDMA system a response packet in response to a packet received from the mobile station, within a same time slot as that used for receiving the packet, wherein the base station includes:

- 5 at least one radio base station operable to demodulate an uplink packet signal received from the mobile station and extract uplink transmission data, and to modulate downlink transmission data to be transmitted to the mobile station and generate a downlink packet signal;
- 10 a communication control station operable to receive the uplink transmission data from the at least one radio base station, generate downlink transmission data corresponding to the uplink transmission data and transmit the downlink transmission data to the at least one radio base station; and
- 15 at least one inter-station transmission path which establishes a wired connection between the at least one radio base station and the communication control station,
- in the at least one radio base station,
- monitoring data is generated for notifying a state
- 20 of the radio base station to the communication control station,
- the monitoring data is time division multiplexed into the uplink transmission data with a slot timing which is only allocated to a downlink, and
- the uplink transmission data and the monitoring data
- 25 are transmitted, to the communication control station, in a TDMA

frame format which is used for a radio link between the radio base station and the mobile station, and

in the communication control station,

the uplink transmission data, which is received from

5 the at least one radio base station, is processed in the TDMA frame format, and

a state of the at least one radio base station is monitored by the monitoring data.

[13] A mobile communication system comprising a mobile station
10 and a base station which is operable to return to the mobile station by means of a TDMA system a response packet in response to a packet received from the mobile station, within a same time slot as that used for receiving the packet, wherein

the base station includes:

15 at least one radio base station operable to demodulate an uplink packet signal received from the mobile station and extract uplink transmission data, and to modulate downlink transmission data to be transmitted to the mobile station and generate a downlink packet signal;

20 a communication control station operable to receive the uplink transmission data from the at least one radio base station, generate downlink transmission data corresponding to the uplink transmission data and transmit the downlink transmission data to the at least one radio base station; and

25 at least one inter-station transmission path which

establishes a wired connection between the at least one radio base station and the communication control station,

the at least one radio base station transmits, to the communication control station, the uplink transmission data in
5 a TDMA frame format which is used for a radio link with the mobile station,

the communication control station processes the uplink transmission data, which is received from the at least one radio base station, in the TDMA frame format, and transmits, to the at
10 least one radio base station, the downlink transmission data in the TDMA frame format, and

the at least one radio base station processes the downlink transmission data, which is received from the communication control station, in the TDMA frame format.

15 [14] The mobile communication system according to claim 13, wherein

the communication control station includes:

a signal generating unit operable to generate a communication control station transmission clock for providing
20 a transmission timing of the downlink transmission data and generate a communication control station reception clock for providing a reception timing of the uplink transmission data;

a data generating unit operable to generate, in accordance with the communication control station transmission
25 clock, the downlink transmission data and transmit the downlink

transmission data; and

a reception unit operable to receive, in accordance with the communication control station reception clock, the uplink transmission data, and

5 the at least one radio base station includes:

a reproduction unit operable to reproduce, from the downlink transmission data received from the communication control station, a radio base station reception clock and a radio base station transmission clock which are synchronized with the
10 communication control station transmission clock; and

a radio unit operable to process the downlink transmission data by using the radio base station reception clock reproduced in the reproduction unit and process the uplink transmission data by using the radio base station transmission
15 clock reproduced in the reproduction unit.

[15] The mobile communication system according to claim 14, wherein the at least one radio base station further includes an adjusting unit operable to control an amount of overall transmission delays of an entire system by adjusting a phase
20 difference, which occurs according to a length of the at least one inter-station transmission path, between the radio base station transmission clock and the communication control station reception clock.

[16] The mobile communication system according to claim 14,
25 wherein

the plurality of radio base stations are connected to the communication control station respectively via the plurality of inter-station transmission paths,

in the communication control station, the reception unit
5 is operable to receive, in a predetermined slot, a plurality of pieces of uplink transmission data, which are respectively outputted from the plurality of radio base stations and correspond to a same packet received from the mobile station, and

the communication control station further includes:

10 a detection unit operable to detect a reception timing of uplink transmission data, the uplink transmission data corresponding to the packet having been first received; and

a selection unit operable to perform a selection process only on uplink transmission data which has been received
15 before a predetermined period of time has passed after the reception timing.

[17] The mobile communication system according to claim 14, wherein the data generating unit of the communication control station generates the downlink transmission data, into which dummy
20 data for reproducing the radio base station reception clock is inserted, and transmits the downlink transmission data in a period which is within the TDMA frame and in which a channel data packet to be transmitted is not present.